



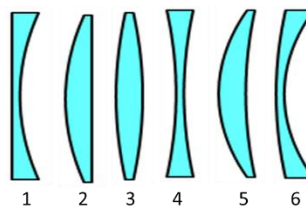
PART I. Multiple choice questions (MCQ) Select one correct answer and label it on the corresponding score sheet.

1. A rocket is fired on level ground at an angle of 40° above the horizontal and performs projectile motion. If air resistance is neglected, determine which statement is true.

- A. The horizontal component of the velocity is zero at the highest point of the flight.
- B. The horizontal component of the velocity first decreases then increases during the flight.
- C. The magnitude of the velocity remains constant during the flight.
- D. The horizontal component of the net force acting on the rocket decreases during the flight.
- E. The acceleration of the rocket points down throughout the flight.

2. Which of the following lenses are diverging?

- A. 1, 4, 5, 6
- B. 2, 3, 5, 6
- C. 2, 3
- D. 2, 3, 5
- E. 1, 4, 6

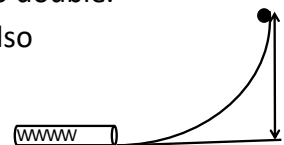


3. What is the wavelength range of visible light?

- A. $4-7.5 \times 10^{-11}$ m
- B. $4-7.5 \times 10^{-9}$ m
- C. $4-7.5 \times 10^{-7}$ m
- D. $4-7.5 \times 10^{-5}$ m
- E. $4-7.5 \times 10^{-3}$ m

4. A ball is shot from a toy gun horizontally as the spring in it returns from its compressed length to its equilibrium length and the ball goes up on a frictionless incline to height h . Which statement is true?

- A. If the compression of the spring is doubled, the initial speed of the ball will also double.
- B. If the compression of the spring is doubled, the height h the ball reaches will also double.
- C. If the spring constant is doubled, the initial speed of the ball will also double.
- D. If the spring constant is doubled, the height the ball reaches will increase to $4h$.
- E. If the compression of the spring is doubled, the initial kinetic energy of the ball will also double.





5. Which of the statements is true about sound?

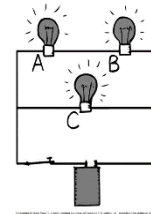
- A. The speed of sound is higher in solids than in gases.
- B. The lower the temperature of air, the higher the speed of sound is.
- C. The audible sound frequency range for humans is 200 Hz – 200 kHz.
- D. Sound can travel in vacuum.
- E. The Doppler effect means that a higher intensity sound is heard by the observer if the source is approaching.

6. The first law of thermodynamics states that

- A. The entropy of a system increases in spontaneous processes.
- B. The internal energy of a system can be increased by supplying heat to it or doing work on it.
- C. Absolute 0 K temperature cannot be reached.
- D. The heat required to increase the temperature of an object is proportional to its specific heat.
- E. The temperature of an ideal gas is directly proportional to the average molecular kinetic energy.

7. What happens if out of the three identical light bulbs bulb C is unscrewed?

- A. Bulbs A and B will become brighter.
- B. The current in the main branch will decrease.
- C. None of the bulbs will be lit.
- D. The total resistance of the circuit will decrease.
- E. The voltage across bulbs A and B will increase.

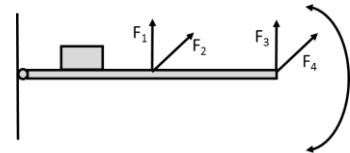


8. Mark and David are loading identical cement blocks onto a truck. Mark lifts his block straight up from the ground to the truck, whereas David slides his block up a ramp on massless, frictionless rollers. Which statement is true?

- A. Mark does more work than David.
- B. Mark and David do the same amount of work.
- C. David does more work than Mark.
- D. None of these statements is necessarily true because the angle of the incline is unknown.
- E. None of these statements is necessarily true because the mass of one block is not given.



9. Two identical sized cubes, one made of wood the other made of iron are placed in water. The iron cube sinks to the bottom, while the wood cube floats on the surface with half of its volume above the surface. Which statement is true?
- A. The buoyant force on the iron cube is greater than the buoyant force on the wood cube.
 - B. The buoyant force on the wood cube is greater than the buoyant force on the iron cube.
 - C. The buoyant forces are equal on the two cubes.
 - D. The buoyant force on the wood cube is greater than its weight.
 - E. The buoyant force on the iron cube is greater than its weight.
10. A plank is attached to the wall with a joint, which allows it to rotate up and down. A box is placed on the plank as shown in the figure. If only one force can be applied, which of the forces (1-4) can have the smallest magnitude to keep the plank horizontal?
- A. Force 1
 - B. Force 2
 - C. Force 3
 - D. Force 4
 - E. The same magnitude of force must be applied in each case, since the weight of the box is the same.





Section I.A. (5 point)

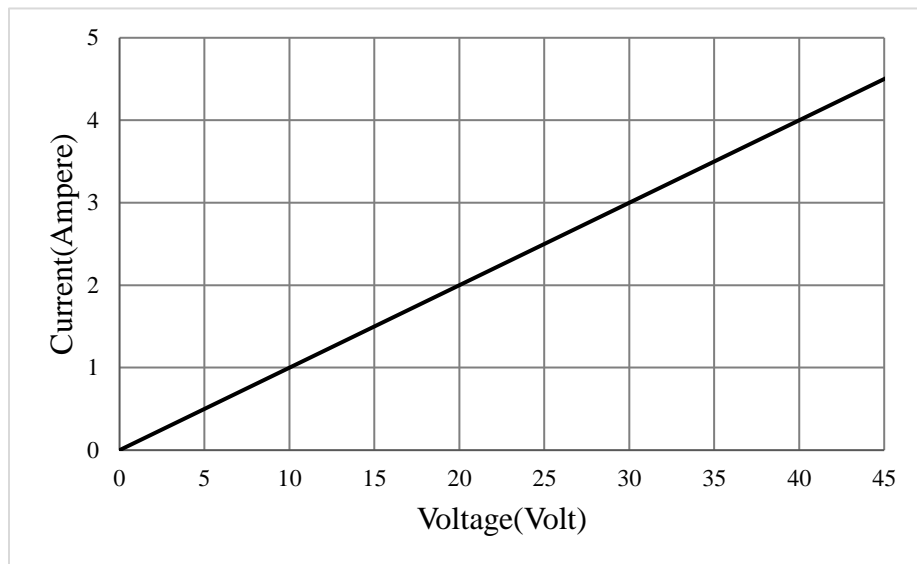
An object floats in a fluid.

- (a) Draw the forces acting on the body. A greater force must be indicated by a longer arrow.
- (b) What is the condition for floating in terms of object and fluid densities?

Section I.B (5 point)

1. The graph below shows the current versus voltage behavior of a resistor.

- A. Explain the theoretical law that can be used to determine the resistance of the wire from the data of the graphs. (Note: the law itself is not enough to get the full point. Explanation is also needed.) (3 points)**
- B. Determine the resistance of the resistor. (2 points)**



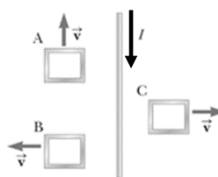


PART II:

Multiple choice questions (MCQ)-Select one correct answer and label it on the corresponding score sheet.

11. Three loops of wire move with constant speed in the directions shown near a long straight wire carrying a current as shown in the figure. What is the direction of the induced current, if any, in loops A, B and C respectively (CW: clockwise, CCW: counterclockwise)?

- A. CW, CW, CCW
- B. CCW, CCW, CW
- C. No current, CW, CCW
- D. No current, CW, CW
- E. No current, CCW, CW



12. A proton enters a homogenous magnetic field with a velocity that is parallel to the field, but opposite in direction. What will its motion be like?

- A. It moves on without a change in its velocity.
- B. It will perform circular motion with constant speed.
- C. It will perform helical (spiral) motion.
- D. It will move on straight with decreasing speed.
- E. It will perform circular motion with decreasing speed.

13. Which statement is false about diverging lenses?

- A. A convex-concave lens may be a diverging lens
- B. The image formed is always virtual
- C. The magnification is always <1
- D. The image may be upright or inverted
- E. The image is always formed in front of the lens.

14. In which of the radioactive decays does the mass number decrease by four?

- A. γ -decay
- B. α -decay
- C. negative β -decay
- D. positive β -decay
- E. none of the decays

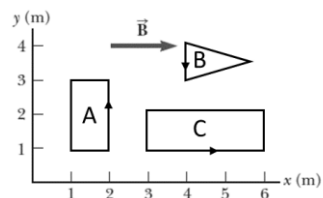


15. Consider an object on a rotating disk a distance r from its center, held in place on the disk by static friction. Which of the following statements is **FALSE** concerning this object?
- A. If the angular speed is constant, the object must have constant tangential speed.
 - B. If the angular speed is constant, the object has zero acceleration.
 - C. The object has a tangential acceleration only if the disk has an angular acceleration.
 - D. If the disk has an angular acceleration, the object has both a centripetal and a tangential acceleration.
 - E. The magnitude of the centripetal acceleration depends on the distance r from the center.
16. When an ice skater is performing a spin and she pulls her extended arms close to her body, her spinning becomes faster because she
- A. increased her angular momentum.
 - B. decreased her angular momentum.
 - C. increased her moment of inertia.
 - D. decreased her moment of inertia.
 - E. applied a torque.
17. Two point charges attract each other with an electric force of magnitude F . If one charge is doubled and the distance between the charges is also doubled, what is the resulting magnitude of the electric force between them?
- A. $F/2$
 - B. $F/12$
 - C. $4F$
 - D. $2F$
 - E. $F/4$



18. A magnetic field exerts a torque on each of the current-carrying single loops of wire shown in the figure. The loops lie in the xy -plane, each carrying the same magnitude current, and the uniform magnetic field points in the positive x -direction. Rank the coils by the magnitude of the torque exerted on them by the field, from largest to smallest.

- A. A, B, C
- B. A, C, B
- C. B, A, C
- D. B, C, A
- E. C, A, B



19. Which statement is true about linear momentum and collisions?

- A. A collision is inelastic only if the two objects move on with a common velocity after the collision.
- B. In an inelastic collision, the momentum of the system is conserved, but kinetic energy is not.
- C. If two particles have equal momenta, their kinetic energies are always equal.
- D. When two objects collide, the change in the linear momentum of the object with the smaller mass will be greater.
- E. If two particles have the same kinetic energy and the same mass they must have the same linear momentum.

20. Which statement is false about diverging lenses?

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Section II. A. (10 points)

Answer each question true or false in the table below. (1 point for each correct answer)

- 1) The latent heat is the amount of energy required to raise the temperature of 1 kg of an arbitrary substance by 1°C .
- 2) The energy needed to raise the temperature of a substance of mass m by ΔT is $cm\Delta T$, where c is the specific heat of the given substance.
- 3) Boiling is exothermic.
- 4) The latent heat of the substance depends on the external temperature.
- 5) When an ideal gas expands at constant pressure, the work done by the gas must be positive.
- 6) The first law of thermodynamics relates changes in internal energy to energy transfers due to heat and work.

Question:	1	2	3	4
True or False:				

Give the exact definition of the following. If you write an equation, interpret the variables.

State Newton's 3rd law. (3 points)

State Archimedes' principle. (3 points)

Section II. B.

Problem solving (10 points)

The density of oxygen gas at $T = 0.00^{\circ}\text{C}$ is $\rho_0 = 1.31 \text{ kg/m}^3$. The temperature is raised then to $T = 50.0^{\circ}\text{C}$, but the pressure is kept constant. Assuming that the oxygen is an ideal gas, calculate the new density of the gas. (10 points)